Illuminance Worksheet KEY

1. Find the illumination 4.0 m below a 405 lm lamp.

$E = ?$
$P = 405\ lm$
$r = 4.0\ m$

$E = \frac{P}{4\pi r^2}$

$E = \frac{405\ lm}{4\pi (4.0\ m)^2}$

$E \approx 2.0\ lx$

2. What is the luminous flux for a light that is sitting 6.00 m from an object with an illumination of 1250 lx?

$P = ?$
$r = 6.00\ m$
$E = 1250\ lx$

$E = \frac{P}{4\pi r^2}$

$E(4\pi r^2) = P$

$P = (1250\ lx)[4\pi (6.00\ m)^2]$

$P \approx 5.65 \times 10^5\ lm$

3. How far is an object with an illumination of 585 lx sitting from a 1535 lm light bulb?

$r = ?$
$E = 585\ lx$
$P = 1535\ lm$

$E = \frac{P}{4\pi r^2}$

$r^2 = \frac{P}{4\pi E}$

$r = \pm\sqrt{\frac{P}{4\pi E}}$

$r = \pm\sqrt{\frac{1535\ lm}{4\pi (585\ lx)}}$

$r = \pm 0.457\ m$

$r \approx 0.457\ m$

4. A screen is placed between two lamps so that they illuminate the screen equally. The first lamp emits a luminous flux of 1445 lm and is 2.5 m from the screen. What is the distance of the second lamp from the screen if the luminous flux is 2375 lm?

$E_1 = E_2$
$P_1 = 1445\ lm$
$r_1 = 2.5\ m$
$P_2 = 2375\ lm$
$r_2 = ?$

$E_1 = \frac{P_1}{4\pi r_1^2}$

$E_2 = \frac{P_2}{4\pi r_2^2}$

$E_1 = E_2$

$\therefore \frac{P_1}{4\pi r_1^2} = \frac{P_2}{4\pi r_2^2}$

$r_2^2 = \frac{P_2 4\pi r_1^2}{P_1 4\pi}$

$r_2^2 = \frac{P_2 r_1^2}{P_1}$

$r_2 = \pm\sqrt{\frac{P_2 r_1^2}{P_1}}$

$r_2 = \pm\sqrt{\frac{(2375\ lm)(2.5\ m)^2}{(1445\ lm)}}$

$r_2 = \pm 3.2\ m$

$r_2 = 3.2\ m$

5. A public school law requires a minimum illumination of 160 lx on the surface of each student desk. An architect's specifications call for classroom lights to be located 2.0 m above the desks. What is the minimum luminous flux the lights must deliver?

$E = 160\ lx$

$P = ?$

$r = 2.0\ m$

$E = \frac{P}{4\pi r^2}$

$E 4\pi r^2 = P$

$(160\ lx)(4\pi)(2.0\ m)^2 = P$

$P \approx 8.0 \times 10^3\ lm$

$P \approx 8042\ lm$

6. A three-way bulb uses 50, 100, 150 W of electrical power to deliver 665, 1620, or 2285 lm in its three settings. The bulb is placed 80.0 cm above a sheet of paper. If an illumination of at least 175 lx is needed on the paper, what is the minimum setting that should be used?

$P_{50} = 665\ lm$

$P_{100} = 1620\ lm$

$P_{150} = 2285\ lm$

$r = 80.0\ cm = 0.800\ m$

$E = 175\ lx$

$E = \frac{P}{4\pi r^2}$

$E 4\pi r^2 = P$

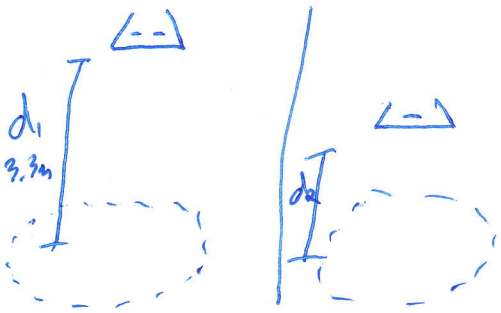
$(175\ lx)(4\pi)(0.800\ m) = P$

$1407\ lm \approx P$

↑ Low setting too little; need medium

You would need to use the second setting of P_{100}.

7. A streetlight contains two identical light bulbs 3.3 m from the ground. If the community wants to save electrical energy by removing one bulb, how far from the ground should the streetlight be positioned to have the same illumination on the ground under the lamp?



$E_1 = \frac{P_1}{4\pi r_1^2}$ $\quad E_2 = \frac{P_2}{4\pi r_2^2}$

$E_1 = E_2$

$P_1 = ?$

$P_2 = \frac{1}{2} P_1$

$r_1 = 3.3\ m$

$r_2 = ?$

$E_1 = E_2$

$\therefore \frac{P_1}{4\pi r_1^2} = \frac{P_2}{4\pi r_2^2}$

$\frac{P_1}{r_1^2} = \frac{P_2}{r_2^2}$

$P_1 r_2^2 = P_2 r_1^2$

$P_1 r_2^2 = \frac{1}{2} P_1 r_1^2$

$r_2^2 = \frac{1}{2} r_1^2$

$r_2 = \pm\sqrt{\frac{1}{2} r_1^2}$

$r_2 = \pm\sqrt{\frac{1}{2}(3.3\ m)^2}$

$r_2 \approx 2.3\ m$